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Title of Manuscript. Climate Engagement in a Digital Age: Exploring the Drivers of Participation in Climate Discourse Online in the Context of COP21

Abstract
Various scholars underscore the importance of public engagement with climate change to successfully respond to the challenges of global warming. However, although online media provide various new opportunities to actively engage in climate discourse through sharing, evaluating or publishing climate-related content online, so far very little is known about the drivers of public participation in climate discourse online. Against this background this study tested a theoretical model on the effects of media and interpersonal communication on participation in climate discourse online using data from a representative online survey of German citizens (n=1,392) carried out while the climate summit in Paris 2015. Over all, the results show that receiving information on climate change from social media (social networks, Twitter, blogs), active information seeking online, and interpersonal conversations about COP21 strongly encourage participation in climate discourse online. Moreover, results provide relevant insights on the role of interest in climate politics, personal issue relevance and climate scepticism as preconditions of communication effects.

Keywords: climate engagement, participation in climate discourse online, media effects, COP21, structural equation model

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Climate Engagement in a Digital Age: Exploring the Drivers of Participation in Climate Discourse Online in the Context of COP21

Climate change is undoubtedly one of the greatest societal challenges of our time. The need to take global action was first recognized in the early 90s with the establishment of the United Nations Framework Convention on Climate Change (UNFCCC). Today, the scientific community has reached a widely accepted consensus regarding the anthropogenic causes and negative impacts of climate change (IPCC, 2013), although some questions remain open (e.g. the role of clouds; Bony et al., 2016). Nonetheless, scientific assessments of climate impacts are strongly related to political, societal and technological developments, as they are often used to anchor public debate about climate change and to justify political climate goals, such as the two-degree target (e.g. Knutti, Rogelj, Sedlacek, & Fischer, 2016). Moreover, even now, the communicative context of global warming can be described as an ongoing debate reflecting various kinds of arguments, positions and controversies (Wibeck, 2014). Therefore, the adoption of collective climate actions is often hindered, and sometimes even intentionally prevented, by the conflicting interests of the various actors involved in that debate. Not without reason, it took the Parties of the UNFCCC over two decades to reach the first universal, legally binding global climate deal, the Paris Agreement, at the climate conference in December 2015.

Given that, a growing number of scholars argue that responding to global warming will not be successful unless the public is also engaged with climate change (e.g., Wibeck, 2014). Thus, public engagement with climate change has been defined both as people's *political engagement with climate political matters* (Carvalho, van Wessel, & Maeseele, 2016; Feldman, Hart, Leiserowitz, Maibach, & Roser-Renouf, 2015; Roser-Renouf, Maibach, Leiserowitz, & Zhao, 2014) and as 'a personal *state* of connection with the issue of climate change' (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007, p. 446; Whitmarsh, Seyfang, & O'Neill, 2011; Wolf & Moser, 2011).

In order to encourage public engagement with climate change in any form, scholars stress the importance of communicating about the causes, impacts and possible solutions (Moser, 2009, 2010; Nisbet, 2009). Therefore, scholars have examined the effects of communication on public engagement and aimed to identify strategies of effective climate communication (Wibeck, 2014). Previous research on the effects of communication on behavioural engagement with climate change mainly focused on the effects of political and issue-specific

media. Moreover, this research dealt with the impact of communication on climate protection by taking mitigation actions in everyday life (Arlt, Hoppe, & Wolling, 2011; Cabecinhas, Lázaro, & Carvalho, 2008) on the one hand and on political climate activism on the other hand (Feldman et al., 2015; Roser-Renouf et al., 2014). However, although scholars from political communication research underline the relevance of online media for public engagement, current climate research mainly focusses on the content and structure of climate discourse in online media (e.g. Elgesem, Steskal, & Diakopoulos, 2015; Jang & Hart, 2015; Matthews, 2015; Sharman, 2014; Williams, McMurray, Kurz, & Hugo Lambert, 2015). Consequently, to date very little is known about the drivers of public participation in climate change discourse online. The only exception, as far as we are concerned, is a recent study by Taddicken and Reif (2016), who developed a typology of Germans' online engagement with climate change by applying cluster analysis to survey data from autumn 2013.

Against this background of this research desideratum, this study aims to explore the factors influencing peoples' participation in climate discourse online in the context of the 21st Conference of the Parties (COP21) held in Paris in December 2015. The annual climate summits do not only serve as a forum for political climate diplomacy, but also as significant points in time to inspire public engagement in climate discourse —either offline or online—as the intensity of media coverage increases enormously in the context of these political events (e.g. Schäfer & Schlichting, 2014; Schmidt, Ivanova, & Schäfer, 2013).

Literature Review

Participation in Climate Change Discourse Online

In view of previous research, scholars have mainly examined three forms of offline participation in climate policy matters: (a) participating in demonstrations or rallies to support climate actions; (b) contacting government officials to urge them to take climate actions; (c) signing a petition to support the reduction of climate change (e.g. Feldman et al., 2015; Lubell, Zahran, & Vedlitz, 2007; Roser-Renouf et al., 2014). However, given the growing importance of the internet, the number of participatory actions that can be taken online is steadily increasing. One the one this involves activities that scratch a shift from offline to online, as most of these actions are 'converted' forms of offline participation (e.g. e-voting, e-petition signing, online donation, contacting politicians online or emailing an editor (Gibson & Cantijoch, 2013)). On the other hand, giving the growing popularity of social networks, various new modes of online participation such as sharing political views on social networks

sites, commenting posts in online forums, or publishing one's own posts on issues have emerged (Bennett, 2012; Hosch-Dayican, 2014; Rojas, 2010). Hence, in view of the traditional conceptualization of political participation, these online activities are less instrumental and targeted to influence policy-making processes, but rather individualized forms of political self-expression (Hosch-Dayican, 2014). Consequently, we can observe an increasing tendency of 'self-actualizing, digitally mediated DIY politics' (Bennett, 2012, p. 30) that, to a great extent, take place outside 'the domain of institutionalized policy making' (Hosch-Dayican, 2014, p. 433). Applying these thoughts to the above-mentioned study of Taddicken and Reif (2016), they have considered three new modes of online participatory activities: (a) sharing messages about climate change in social networks; (b) commenting on climate messages online news sites; (c) publishing one's own climate messages on blogs.

Yet, someone could argue that public engagement with climate change through such online activities is less significant than offline activities that are explicitly targeted at influencing climate policy-making processes. However, there is strong empirical evidence that undermines the crucial potential of online discourse to affect (offline) public opinion about climate change, which, in turn, may affect political outcomes. First, various scholars have witnessed that climate-sceptic arguments are more apparent in online media (online user comments: Koteyko, Jaspal, & Nerlich, 2013; weblogs: Matthews, 2015; Sharman, 2014) and that weblogs are even able to set the agenda of traditional mass media (Hellsten & Vasileiadou, 2015). Second, public discourse in online social networks is strongly polarized between climate sceptics and non-sceptics (Jang & Hart, 2015) and typically happens within polarized echo chambers, where people mostly interact with like-minded others (Williams et al., 2015). Third, considering the concept of opinion leadership (Lazarsfeld, Berelson, & Gaudet, 1944), scholars argue that individuals who spread messages on climate change through their social networks and discuss the issue on Twitter might take over a role as 'digitally networked climate leaders' (Kirilenko & Stepchenkova, 2014; Nisbet & Kotcher, 2009, p. 336). In turn, these digital opinion leaders can have a strong influence on some segments of the population (e.g. the doubtful about climate change) in which personal relations to family and friends are the most trusted information sources about climate change (Leiserowitz, Maibach, & Roser-Renouf, 2009).

Effects of Media Communication on Participation

Initial insights into the role of media communication on participation in climate discourse online can be drawn from the study of Taddicken and Reif (2016). However, as the typology contained not only participatory activities (sharing, commenting, rating and publishing), but also active information seeking on climate change using search engines. In the context of the present study, we focus on the small group of 'participating experts', which represent approximately 2% (*n*=34) of the total sample of *n* = 1,463 (Taddicken & Reif, 2016, p. 324). People belonging to this group did not only participate most actively in climate discourse online, but they were also exposed the most to information about climate change from traditional mass media (e.g. public and private television, newspapers and magazines) and online media (e.g. online newspapers, news platforms, social networking sites, blogs).

Hence, to gain a more comprehensive understanding how communication affects (online) political participation, we want to give a short overview about findings stemming from political communication research. Numerous studies regarding the effects of *traditional mass media* have reported positive effects of using newspapers on political participation (Hardy & Scheufele, 2005; McLeod, Scheufele, & Moy, 1999; Scheufele & Nisbet, 2002), forum participation (Scheufele & Nisbet, 2002) and civic participation (Shah, McLeod, & Yoon, 2001; Shah, Cho, Eveland, & Kwak, 2005; Shah et al., 2007). For television news exposure, however, the findings are mixed. While some scholars have explored the mobilizing effects of television hard-news use on political participation (Gil de Zúñiga, Veenstra, Vraga, & Shah, 2010; McLeod et al., 1996), others could not confirm this positive relation (Hardy & Scheufele, 2005; Scheufele & Nisbet, 2002; Shah et al., 2005; Shah et al., 2007).

With respect to effects of the *internet*, they seem to strongly depend on the form of internet use. First, scholars found that seeking information online positively affects participation behaviours (Hardy & Scheufele, 2005; Tolbert & McNeal, 2003) and political self-expression online (Gil de Zúñiga et al., 2010; Shah et al., 2007). Second, using the internet for exchanging information and interactive political messaging inspires civic participation (Shah et al., 2001; Shah et al., 2005; Shah et al., 2007). Overall, as the results of a meta-analysis of 38 studies reveal, internet use and participation are related in a positive, but rather weak manner; however, the relation seems to be stronger for using the internet for information purposes (Boulianne, 2009). Recent studies have more strongly focused on the effects of *social media use* on participation and civic engagement. A meta-analysis of 22 studies has

shown that while using social media for news and information has mobilizing effects, there are no such effects for identity and entertainment-oriented social media use (Skoric, Zhu, Goh, & Pang, 2015). Moreover, informational social media use is strongly related to political expression online (Bode, Vraga, Borah, & Shah, 2014; Gil de Zúñiga, Molyneux, & Zheng, 2014).

Effects of Interpersonal Communication on Participation

As already discussed above (political) information and news are important prerequisites of online and offline political participation. Besides (mass) media, communication scholars stress the importance of interpersonal communication as another source of information as individuals at least sporadically discuss political issues with friends, colleagues, family members and co-members of social groups. Therefore, these interpersonal communication networks have the 'function to review and elaborate one's understanding of political issues' (Boomgaarden, 2014, p. 473)—often mediated by (mass) media. The importance of interpersonal communication to affect people's political attitudes and behaviours was first recognised by Lazarsfeld et al. (1944), who developed the two-step flow of communication model. This paradigm assumes that most individuals do not receive their information from the mass media directly but, instead, through interpersonal conversations with well-informed, politically interested opinion leaders within their interpersonal social networks. Thus, rather than affecting people directly, the mass media influences citizens indirectly, mediated through interpersonal communication. Regarding the *effects of interpersonal communication* on political participation, there is strong evidence supporting the two-step flow model of communication (Lazarsfeld et al., 1944). Various studies have observed indirect effects of mass communication through interpersonal discussion (McLeod et al., 1996; McLeod et al., 1999; Shah et al., 2005; Shah et al., 2007). Besides, studies discovered that interpersonal communication directly affects political expression online via social media (Gil de Zúñiga et al., 2014). Studies from the field of climate communication even explored positive effects of interpersonal discussion about climate change on participation in climate matters (climate activism; Feldman et al., 2015; Roser-Renouf et al., 2014).

Preconditions of Climate-related Communication and Participation Behaviours

However, despite the substantial empirical evidence for effects of media use and interpersonal communication on online and offline (political) participation, it must be acknowledged that communication behaviours and participation strongly depend on *personal characteristics* of

the audience and their *selective exposure* to information (Valkenburg, Peter, & Walther, 2016). Likewise, studies on audience segmentation in the context of climate change have shown that population segments that strongly differ in their attitudes towards climate change also have very diverse issue-specific communication patterns. For example, US-American participants who doubt the existence of global warming tend to rely on their interpersonal communication networks as their trusted source of information on the issue, while alarmed citizens heavily use all types of mass media (Leiserowitz et al., 2009). Likewise, the findings from a typology of attitudes about climate change of German citizens reveal that those who are alarmed about global warming more frequently use different sources of information on the issue, including personal conversations (Metag, Füchslin, & Schäfer, 2015). Moreover, the typology of German's online engagement in climate discourse revealed that those who participated the most frequent in climate discourse online, the 'participating experts', were strongly interested in the issue of climate change, but at the same time did not strongly believe in anthropogenity of global warming (Taddicken & Reif, 2016, p. 327). Likewise, studies that examined the content and structure of climate discourse online explored that people holding more *sceptical* attitudes towards climate change seem to be more actively engaged in climate discourses online (e.g. Jang & Hart, 2015; Koteyko, Jaspal, & Nerlich, 2013; Matthews, 2015; Sharman, 2014). Finally, various studies from political communication research have shown that people who are more strongly *interested in politics* show higher levels of political participation (Hardy & Scheufele, 2005; McLeod et al., 1999).

Research Model and Hypotheses

As stated before, the aim of this study is to explore and explain the peoples' participation in climate discourses online in the context of the COP21. Based on the previously discussed literature (e.g., Bennett, 2012; Hosch-Dayican, 2014; Rojas, 2010), this study focuses on activities that—to a certain degree—*contribute, enhance*, or *enable* public discourses about climate change online through sharing information or expressing one's own views about climate change online (e.g., Taddicken & Reif, 2016). Regarding the effects of communication, previous research has demonstrated that the mobilizing potentials strongly vary across different forms of communication and media. Therefore, we expect differentiated effects. Figure 1 summarizes the assumed effects of media and interpersonal communication on participation in climate change discourse online. Previous research has shown that using the internet for news is positively related to various forms of participation (Boulianne, 2009) and that active information seeking online stimulates political self-expression online (Gil de Zúñiga et al., 2010; Shah et al., 2007). Thus, we hypothesize that participating in climate

change discourse online will be positively driven by reading online newspapers (H1) and active information seeking on climate change online (H2). Hence, based on studies that observed positive effects of using various forms of social media for information on online expression (Bode et al., 2014; Gil de Zúñiga et al., 2014; Skoric et al., 2015; Yang & DeHart, 2016), it also seems likely to expect positive effects of using social media on participation in climate discourse online. Thus, to examine these effects on a more differentiated basis, we assume positive effects of an informational use of social network sites (H3a), Twitter (H3b), and weblogs (H3c) on climate-related online participation.

Existing research has provided substantial empirical evidence that reading print media inspires—directly and indirectly—traditional (offline) forms of political participation; however, the mobilizing effect of TV news exposure seems to be rather mediated through interpersonal communication (e.g. Hardy & Scheufele, 2005; McLeod et al., 1996; McLeod, Scheufele, & Moy, 1999; Scheufele & Nisbet, 2002; Shah, Cho, Eveland, & Kwak, 2005; Shah et al., 2007; Sotirovic & McLeod, 2001). Bases on this rationale, we assume that watching television news will have a positive effect on participation in climate discourse online through interpersonal conversation (H4, full mediation), while reading print media will positively affect participation directly (H5a) and indirectly (H5b, partial mediation). Regarding the effect of interpersonal conversations about politics in general (e.g. Gil de Zúñiga et al., 2010; McLeod et al., 1996; McLeod et al., 1999) and about climate change in particular (Feldman et al., 2015; Lubell et al., 2007; Roser-Renouf et al., 2014), previous research has shown that interpersonal communication strongly motivates political action. Accordingly, we expect that interpersonal conversations about climate change will motivate participation in climate change discourse online (H6). However, climate-related online participation will not only depend on people's climate-related communication behaviours, but also on their climate-related *personal attributes*, which must be taken into consideration to adequately explore the effects of communication on participation in climate discourse online. To do so, we will control for the effects of interest in climate politics, the personal relevance of climate change, and climate scepticism (see Figure 1).

<< Insert Figure 1 here >>

Methods

Sample

The data used in this study originate from a three-wave online panel survey of German citizens conducted in the context of the UN Climate Conference hold in Paris in November 2015. The respondents were recruited via a German online access panel of the professional external panel provider respondi, which is certified according to Global ISO 26362, and a member of ESOMAR and DGOF. The sample is supposed to be representative for the German population based on quotes for age, sex (crossed) and education. However, as variables on communication and online participation related to the climate summit were only assessed in the second wave, which was carried out during the climate conference (6th to 10th December 2015), the present study is based on cross-sectional data from respondents who participated in the second wave. In total 1,392 individuals (48% females; 52% males; *M* = 46.4 years of age, *SD* = 13.4) provided valid data on the relevant variables examined on this study.

Measures

Media exposure and interpersonal conversation about COP21. People's media exposure and interpersonal conversation regarding the climate summit in Paris were examined with nine items. Respondents were asked to indicate on a seven-point scale (1 'never' to 7 'several times a day') how often they have recently received information on COP 21 from *television news and informational programs* (*M* = 4.1; *SD* = 1.6), *printed newspapers and magazines* (*M* = 2.6; *SD* = 1.8), *online newspapers* (*M* = 2.1; *SD* = 1,7), *social network sites* (*M* = 2.1; *SD* = 1.8), *Twitter* (*M* = 1.4; *SD* = 1.1) and *weblogs* (*M* = 1.4; *SD* = 1.1). Moreover, using the same seven-point scale we asked participants how often they *actively sought information on the climate summit 2015 online* (*M* = 1.9; *SD* = 1.4) and third, how often they discussed the climate summit with *family and friends* (*M* = 2,4; *SD* = 1.6) and with *colleagues* (*M* = 2,1; *SD* = 1.5). For further analysis, a mean score for *interpersonal conversations* was calculated (*M* = 2.2; *SD* = 1.4; Cronbach's α = .87. (see Supplementary Table 1)

Participation in climate discourse online. The extent of people's participation in climate discourse online in the context of the climate summit was captured with four items asking respondents to indicate on a seven-point scale (1 'never' to 7 'several times a day') how often they had evaluated, commented on, shared or published their own posts on climate change/politics (for descriptives, see Table 1). For further analysis, a mean score for

participation in climate discourse online was calculated (*M* = 1.5; *SD* = 1.1; Cronbach's α = .95)

<< Insert Table 1 here >>

Control variables. Interest in climate politics was measured with one item asking respondents to indicate how strongly they are interested in climate politics on a five-point scale (1 'not strongly at all' to 5 'very strongly', (*M* = 3.2; *SD* = 1.0). *Personal relevance of climate change* was assessed with one item asking respondents to indicate how important the issue of climate change is for themselves on a five-point scale (1 'not important at all' to 5 'very important', *M* = 3.8; *SD* =1.0). Attitudes towards climate change were examined using the following four statements on a five-point likert scale (1 'strongly disagree' to 5 'strongly agree'): 'It is not certain that there is a long-term trend of global warming' (*M* = 2.4; *SD* =1.2), 'Scientists exaggerate the dangers of climate change' (*M* = 2.4; *SD* = 1.1), 'Human activities are the main cause of the current climate change' (*M* = 3.8; *SD* = 1.1) and 'Climate change has serious consequences for humans and nature' (*M* = 4.2; *SD* = 0.9). For further analysis, we recoded items 3 and 4 and conducted a mean score for *climate scepticism* (*M* = 2.2, *SD* = 0.9; Cronbach's α = .80), where higher values indicate higher scepticism towards climate change. (see Supplementary Tables 2-4)

Analysis strategy

To test the hypotheses, a structural equation model (SEM) was calculated (maximum likelihood estimations) by using the Analysis of Moment Structures statistical software program (AMOS24). By means of this analytical approach, it was possible to analyse complex relationships between communication variables and participation in climate discourse online in the context of the climate summit. Moreover, we are able to estimate direct and indirect effects in one single model. As a starting point, we specified an SEM containing all paths postulated in our hypotheses and monitoring the effects of the control variables both on communication variables and online participation (see Figure 1).[1]

[1] Structural equation modeling (SEM) is an extension of generalized linear models (GLM), which allows testing a set of regression equations simultaneously. The SEM presented in Figure 2 examines nine regression equations at once; one for each media variable, one for interpersonal communication, and one for participation in climate discourse online. Observed variables are symbolized by rectangles and the error variances respectively residuals by circles. The assumed direct effects of the variables on media and interpersonal communication as well as of the control variables are represented by single-headed arrows. The assumed correlations between the residuals of the media variables and the control variables are not displayed in Figure 1 for reasons of clarity and comprehensibility (see Supplementary Table 5).

Furthermore, we assumed that the control variables and the residuals on of the media variables are correlated. Considering the ratio of chi-square values and degrees of freedom (Chi^2 / df <3), the root mean square error of approximation (RMSEA<.06), and the comparative fit index (CFI >.95) as model fit indicators and presuming that model should not significantly differ from our data (Hu & Bentler, 1999; Kline, 2011), the fit of the initial model was rather unsatisfactory. However, based on the modification indices, that externalized that some additional communication effects were missing in our initial model, we changed the model (see Figure 2) and could obtain a satisfactory model fit (Chi^2 / df = 2.06; RMSEA = .03, CFI = 1.0, p=.127).[2]

Results

Direct communication effects on participation in climate change discourse online

The objective of the present study is to detect which factors drive people's participation in climate change discourse online. The key findings that answer this question are presented in Figure 2. Most hypotheses were supported by the data. Individuals who more actively seek for information on the climate summit online show higher levels of online participation in climate change discourse (ß = .40; $p < .001$; H2). Likewise, those persons regularly receiving information on the COP21 from social network sites (ß = .15; $p < .001$), Twitter (ß = .08, $p < .001$) and weblogs (ß = .25; $p < .001$) are more strongly engaged in climate change discourse online (H3a, H3b and H3c). Moreover, people who more often discuss the climate conference also participate more frequently in climate change discourse online (ß = .18; $p < .001$; H4). In contrast, neither the direct effect of reading online newspapers (H1) nor the one of using print media (H4a) on online participation were supported by the data. Moreover, our data revealed a negative effect of watching televisions news; meaning that people receiving more information on the climate summit from television show lower levels of online participation (ß = -.05; $p = .003$).

Indirect media effects on participation in climate change discourse online

Besides direct effects, the results showed some indirect effects of media use on online participation through interpersonal conversation (see Table 2). As predicted by H4 and H5a, a higher intensity of climate change-related television exposure (ß = .02; $p = .001$) and print

[2] Based on the modification indices we considered further effects of receiving information on COP21 from television news on online participation as well as from online media (active information seeking online, using social network sites, and weblogs) on interpersonal conversations.

media use (ß = .03; p = .001) leads to more online participation through interpersonal conversations about the climate summit. Based on the refined model (see the section on the analysis strategy), the present study further explored indirect effects of (1) actively seeking for information (ß = .07; p = .001), (2) receiving information on the COP21 from social network sites (ß = .02; p = .001), and (3) weblogs (ß = .02; p = .001) on online participation through interpersonal conversation (see Table 2).

Effects of the personal position on participation in climate change discourse online

Besides the effects of media exposure and interpersonal conversation, the findings provide some important insights into the critical role of the individuals' position concerning climate change. In contrast to various studies that revealed positive effects of political interest on participation, the present research found a negative effect of interest in climate change politics. Thus, individuals who were more interested in climate change politics participated less often in climate change discourse online (ß = -.06; p < .008). Conversely, people with more sceptical attitudes towards climate change show higher levels of participation in climate change discourse online (ß = .08; p < .001). Overall, we were able to explain 68% of the variance in participation in climate change discourse online and 53% of the variance in interpersonal conversations about the COP21 by the suggested model (see Figure 2).

Predictors of climate related communication behaviour (control variables)

The SEM provided some further insights in the crucial role of interest in climate politics, personal relevance of climate change and climate sceptic attitudes as preconditions of climate-related communication behaviours (Table 3): First, people who are more interested in climate politics overall communicate more frequently about the climate summits. This general positive effect was confirmed for the exposure to mass media (television (ß =.35, p <.001), print media (ß =.22, p <.001)), interpersonal conversation (ß =.12, p <.001), the use of online media ((online newspapers (ß =.23, p <.001), information seeking online (ß =.34, p <.001)) as well as the use of social media outlets ((social network sites (ß =.19, p <.001), Twitter (ß =.16, p <.001) and blogs (ß =.26, p <.001)). Second, people who perceive the issue of climate change as strongly relevant for themselves more often receive information from television (ß =.08, p =.023) and print media (ß =.09, p =.018) on the climate summit and more frequently seek information on COP21 online (ß =.14, p <.001). Third, people holding more sceptical attitudes towards climate change more often receive information on the climate summit from social media sources (social network sites (ß =.17, p <.001), Twitter (ß =.16, p <.001),

weblogs (ß =.20, p <.001)) and active information seeking online (ß =.13, p <.001). For climate sceptics, those 'alternative sources' even seem to be more relevant information sources than mainstream media sources (television (ß =.05, n.s.), print media (ß =.08, p <.01) and online newspapers (ß =.09, p <.003)). Additional findings on correlational relations are presented in the Supplementary Table 5).

<< Insert Figure 2 here >>

Discussion

To face the challenges of global warming successfully, citizens must actively engage in public discourses on climate change and climate politics. While previous studies dealt with the growing importance of online media to encourage new forms of more self-expressive and individualized online engagement (e.g. Bennett, 2012; Hosch-Dayican, 2014; Rojas, 2010), very little is known about the factors affecting citizens' participation in climate change discourse online (e.g. Taddicken & Reif, 2016). Against this background, the present study sought to explore the relationship between climate change-related communication (media, interpersonal) and online participation in in the context of climate summit that took place 2015 in Paris. This study derived its hypotheses on communication effects on participation building upon outcomes from climate and political communication research (see Figure 1). To test these hypotheses, structural equation modelling was applied to data from a quantitative survey with a quota sample of 1,392 German citizens, which was conducted during the COP21 (see Figure 2).

With respect to the effects of various communication variables, the results strongly supported previous research that there is an overall positive relationship between using the Internet for information and participation (e.g. Boulianne, 2009). Nevertheless, the strength of this effect appears to depend strongly on the *mode* of usage (i.e. active vs. passive) and the specific online *platform*. Actively seeking for information on the climate summit online had the strongest effect on online participation. Compared to that, the effect of the passive consumption of information provided by various media was small. Consistent with previous research on social media effects (e.g. Bode et al., 2014; Skoric et al., 2015), we found strong evidence that receiving information on the COP21 from social media outlets strongly encourages individuals' participation in climate change discourse online. Overall, the effects are stronger for weblogs and social network sites than for Twitter. This finding may be explained by the nature and audience of these online outlets. Twitter is primarily used as a

communication channel by professionals such as journalists, politicians and representatives of non-governmental organizations which, at least in Germany, are only followed by a small number of people. Social network sites such as Facebook, however, are quite popular among the German population as they allow people to personally connect with others and to actively exchange and discuss stories and issues that matter to them. By contrast, issue-specific blogs provide their – often only a few – users with very specific, often alternative information and personal viewpoints on controversial issues such as climate change (e.g., the climate sceptic blog 'Watts Up With That?'). Thus, a final evaluation of the effects of information received through social media channels is not possible without knowing more about the actual content.

In addition, our results show that not only online media are important but also that interpersonal conversation and communication transported by mass media are significant drivers of online participation—either through a direct or an indirect relationship. First, our study strongly supports the findings of prior studies (e.g. Feldman et al., 2015; Roser-Renouf et al., 2014) that interpersonal conversations encourage climate change-related participation. Moreover, we found that receiving information on the COP21 from television and print media positively affects participation in climate change discourse online through interpersonal conversation. This finding supports the assumptions of the two-step flow model of communication (Lazarsfeld et al., 1944). Similarly, we found indirect effects of (1) seeking for information online, (2) using social network sites and (3) weblogs through interpersonal conversation on online participation. In other words, people who more frequently receive information by actively seeking online, using social network sites and weblog are more likely to discuss their knowledge about the climate summit with their family, friends and colleagues. In turn, they are more likely to actively engage in online discourses on climate change. These results are backed by previous research demonstrating, that interpersonal discussions are important means to elaborate information conveyed by media (e.g., Trepte & Schmitt, 2017). This knowledge, people may gain in the context of political conversations and media exposure, in turn, may foster their confidence to participate effectively in the political process, which, in turn, is the pathway for active political participation (e.g., Schmitt, 2016). Moreover, this study revealed central effects of people's interest in climate change politics and climate scepticism, which require some further interpretation. Our results show that participation in climate change discourse online is negatively affected by individuals' interest in climate change politics, meaning that people who utter greater interest in climate change politics tend to participate *less* in online discourses. In contrast, people with more sceptical

attitudes towards climate change show a *greater* tendency to participate actively in online climate change discourse. One reasonable explanation refers to our operationalization of participating in climate change discourse online that comprises evaluating, commenting, sharing and publishing own posts on climate change/politics—actions that in general are connected with rather low level of personal involvement. Recent research has shown that climate change skeptics are more likely to be actively apparent in online media than people who are less skeptical (e.g. Koteyko, Jaspal & Nerlich, 2013; Matthews, 2015; Sharman, 2014). Thus, climate sceptics may feel that they need to make use of online media to encounter the public mainstream discourse by commenting on posts on climate change or publishing their own skeptic ideas, for example in weblogs. In this context, the *corrective action hypothesis* (Rojas, 2010) is a useful theoretical explanation. It states that people, who perceive the media as biased against their views (e.g., climate sceptics) and powerful to influence public opinion, are more likely to take discourse actions as they want to express their own opinions in order to correct the perceived hostile media bias and public opinion. Given the contextual situation of the climate change debate in Germany (see Schäfer, 2016), public discourse already reflects the views of those with a strong interest in—and high awareness of the problem of—climate change, as well as those being aware of the political movements seeking to combat global warming. Therefore, for people who are *really* interested in climate change and climate protection it seems plausible that they engage in other rather high-involvement forms of political engagement, e.g. adapting their consumer behavior or signing (online-)petitions. However, further research is needed to shed more light on this assumption.

Overall, the results show that only a minority of the interviewed German citizens actively participate in climate change discourse online by evaluating, commenting, sharing, and publishing own posts (see Table 1). However, given that climate change skepticism has been found to be most apparent in online media—and the internet even has the power to rapidly spread questionable information (e.g, ‘fake news’, ‘alternative facts’)—even a few people are enough to influence and shape public discourse about climate change if they take on the role of digital opinion leaders. The question of whether participation in online climate change discourses have positive or negative consequences for public discourse about climate change and climate protection has to remain unanswered for now as we need more insights about the content, valence and quality of posts and arguments that are actually ‘liked’, posted, and shared by the people actively participating in the online discourse.

Despite the findings discussed above, this study has some methodological weaknesses that need to be acknowledged and that should be addressed in future research. First, climate summits are special points in time as they attract enormous political and media attention. Thereby, they might inspire more public engagement in climate change discourse. However, the crucial questions of whether annual climate summits have the potential to mobilize and increase more public online participation in climate change discourses and how long this mobilization lasts has to be answered using longitudinal data. This would allow researchers to go beyond the exploration of individual differences in the extent and character of online participation, and to examine changes on the individual-level of online participation in climate discourses over time. Likewise, future studies could explore whether changes in people's participation in online climate change discourses might be triggered by 'critical discourse moments . . . such as international summits or the launch of reports of the Intergovernmental Panel on Climate Change' (Carvalho & Burgess, 2005, p. 1461–1462). Second, this study uses data from an online panel survey as therefore the willingness to actively engage in climate change discourses online and the effects of online media might be stronger than in a sample consisting of both "onliners" and "offliners".

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Appendix

<< Insert Table 2 here >>

<< Insert Table 3 here >>

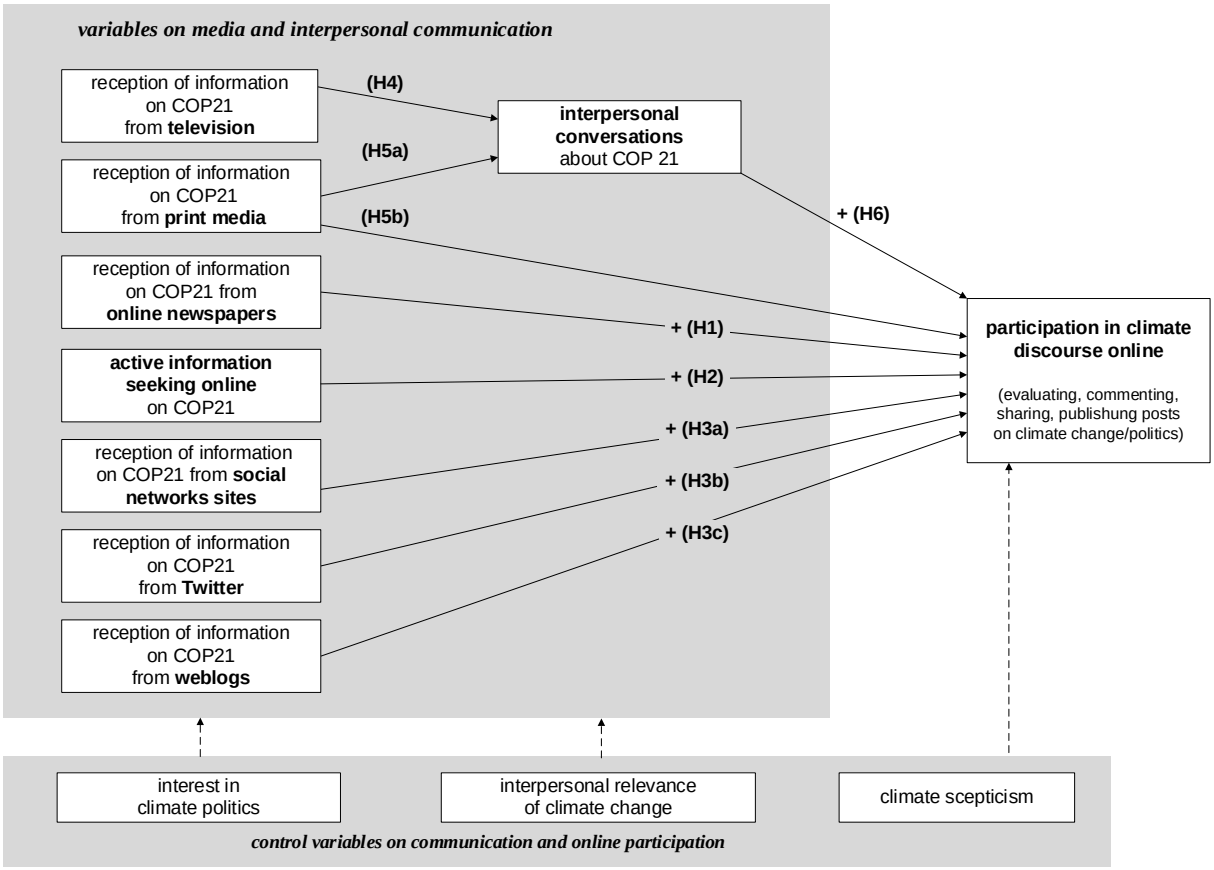

Figure 1. *Research model with theoretical hypothesized effects*

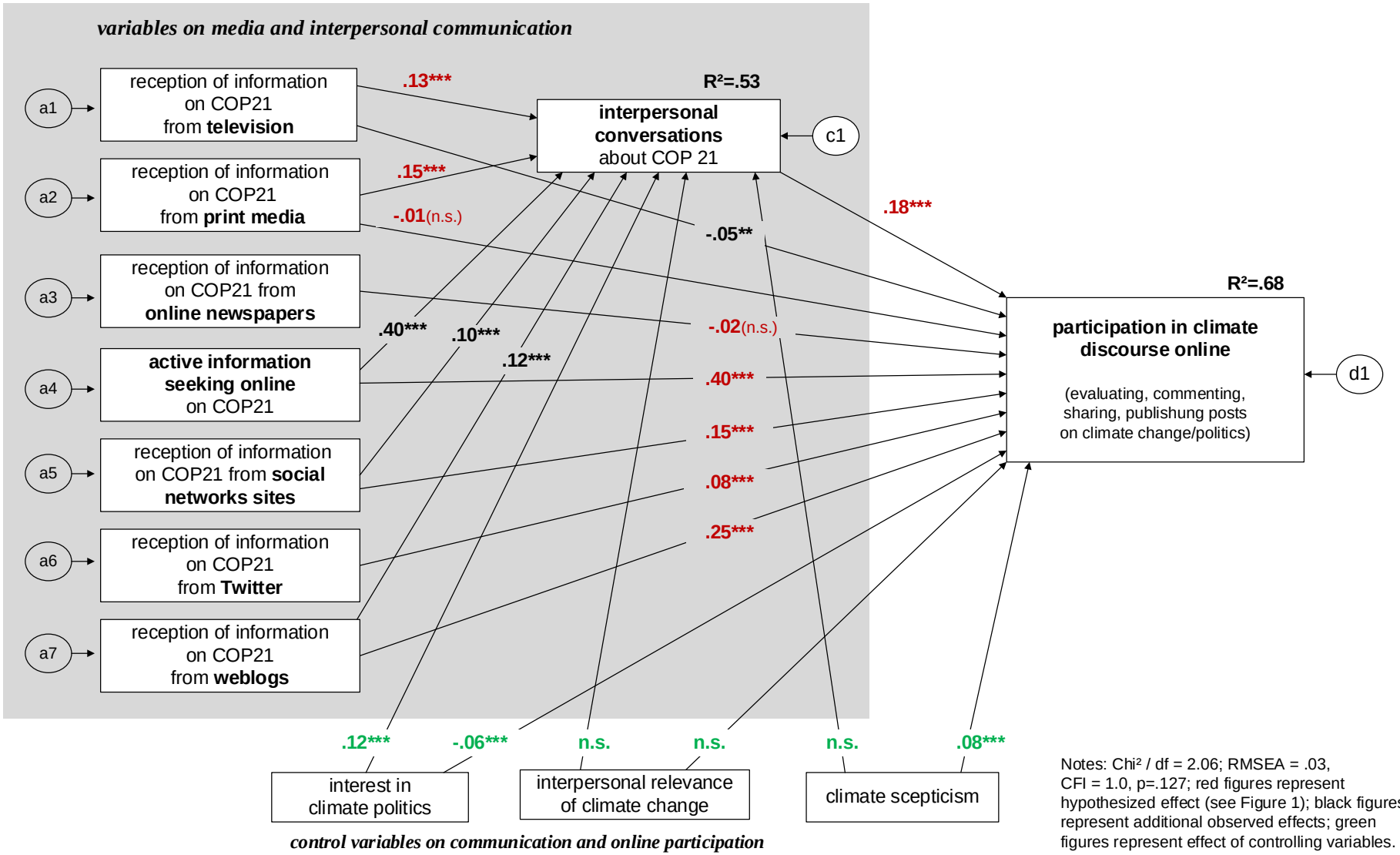

Figure 2. *Results of the structural equation model for participation in climate discourse online*

Table 1. *Operationalization of Participation in Climate Discourse Online*

	M (SD)[1]	never	less	several times a month	at least once a week[2]	daily[3]
Evaluating posts on climate change/politics	1.5 (1.2)	79%	10%	3%	7%	2%
Commenting on posts on climate change/politics	1.5 (1.2)	80%	8%	4%	6%	2%
Sharing posts on climate change/politics	1.5 (1.2)	78%	10%	3%	7%	2%
Publishing one's own posts on climate change/politics	1.3 (1.0)	86%	6%	3%	4%	2%

Notes: [1]Mean (*M*) and standard deviation (*SD*) on a 7-point scale of 1 'never', 2 'less', 3 'several times a month', 4 'once a week', 5 'several times a week', 6 'daily', 7 'several times a day'; [2] points 4 & 5 on the scale; [3]points 6 & 7 on the scale; *n* = 1.392 people.

Table 2. *Summary of Standardized Indirect Effects on Online Participation*

Standardized Indirect Effects			**ß**	**p**
participation in climate discourse online through evaluating, commenting on, sharing and publishing post on climate change/ politics	←	interest in climate politics (strong)	.29	.001
	←	personal relevance of climate change (strong)	.09	.01
	←	climate scepticism (strong)	.16	.01
	←	information on COP21 from television	.02	.001
	←	information on COP21 from print media	.03	.001
	←	information seeking on COP21 online	.07	.001
	←	information on COP21 from social networks sites	.02	.001
	←	information on COP21 from weblogs	.02	.001

Notes: The significance of indirect effects has been assessed using bootstrapping in AMOS; reading example: The standardized indirect effect of receiving information on COP21 from television on participation in climate discourse online is significantly different from zero at the p=.001 level (one-sided).

Table 3. *Summary of Direct Effects of Controlling Variables on Media Communication*

standardized direct effects			**ß**	**p**
information on COP21 from television (R^2 = .15)	←	interest in climate politics (strong)	.35	<.001
	←	personal relevance of climate change (strong)	.08	.023
	←	climate scepticism (strong)	.05	n.s.
information on COP21 from print media (R^2 = .07)	←	interest in climate politics (strong)	.22	<.001
	←	personal relevance of climate change (strong)	.09	.018
	←	climate scepticism (strong)	.08	.01
information on COP21 from online newspapers (R^2 = .06)	←	interest in climate politics (strong)	.23	<.001
	←	personal relevance of climate change (strong)	.07	n.s.
	←	climate scepticism (strong)	.09	.003
information seeking on COP21 online (R^2 = .15)	←	interest in climate politics (strong)	.34	<.001
	←	personal relevance of climate change (strong)	.14	<.001
	←	climate scepticism (strong)	.13	<.001
information on COP21 from social networks sites (R^2 = .05)	←	interest in climate politics (strong)	.19	<.001
	←	personal relevance of climate change (strong)	.06	n.s.
	←	climate scepticism (strong)	.17	<.001
information on COP21 from Twitter (R^2 = .04)	←	interest in climate politics (strong)	.16	<.001
	←	personal relevance of climate change (strong)	.05	n.s.
	←	climate scepticism (strong)	.16	<.001
information on COP21 from weblogs	←	interest in climate politics (strong)	.26	<.001
	←	personal relevance of climate change (strong)	.04	n.s.

(R^2 = .07)	←	climate scepticism (strong)	.20	<.001

Notes: n.s. = not significant

Supplementary Materials for

Climate Engagement in a Digital Age: Exploring the Drivers of Participation in Climate Discourse Online in the Context of COP21

Supplementary Table 1. *Operationalization of Media and Interpersonal Communication Variables*

	M (SD)[1]	never	less	several times a month	at least once a week[2]	daily[3]
reception of information on COP21 from …						
television	4.1 (1.6)	7%	18%	8%	47%	21%
print media	2.6 (1.8)	44%	19%	4%	23%	10%
online newspapers	2.1 (1.7)	63%	12%	4%	16%	6%
social networks sites	2.4 (1.9)	64%	11%	4%	10%	10%
Twitter	2.1 (1.8)	86%	5%	2%	4%	3%
weblogs	1.4 (1.1)	83%	7%	2%	6%	2%
active information seeking online on COP21	1.9 (1.4)	63%	17%	6%	11%	3%
interpersonal conversations about COP 21 with…						
family and friends	2.4 (1.6)	41%	26%	7%	22%	5%
colleagues	2.1 (1.5)	54%	21%	7%	15%	4%

Notes: [1]Mean (M) and standard deviation (SD) on a 7-point scale of 1 'never', 2 'less', 3 'several times a month', 4 'once a week', 5 'several times a week', 6 'daily', 7 'several times a day'; [2] points 4 & 5 on the scale; [3]points 6 & 7 on the scale; n=1.392 people

Supplementary Table 2. *Operationalization of Interest in Climate Politics*

	M (SD)[1]	not strongly at all (1)	not very strong (2)	somewhat strong (3)	rather strong (4)	very strongly (5)
How strong is your interest in politics in general?	3.2 (1.0)	6%	13%	45%	28%	8%

Notes: [1]Mean (M) and standard deviation (SD) on a 5-point scale of 1 'not strongly at all' to 5 'very strongly'.

Supplementary Table 3. *Operationalization of Personal Relevance of Climate Change Politics*

	M (SD)[1]	not important at all (1)	not very important (2)	somewhat important (3)	rather important 4)	very important ' (5)
How important to you are the problems due to climate change?	3.8 (1.2)	3%	7%	24%	40%	27%

Notes: [1]Mean (M) and standard deviation (SD) on a 5-point scale of 1 'not important at all' to 5 'very important'.

Supplementary Table 4. *Operationalization of Attitudes Towards Climate Change*

	M (SD)[1]	strongly disagree (1)	somewhat disagree (2)	neither agree nor disagree (3)	somewhat agree (4)	strongly agree (5)
It is not certain that there is a long-term trend of global warming.	2.4 (1.2)	27%	28%	26%	12%	7%
Scientists exaggerate the dangers of climate change.	2.4 (1.1)	26%	32%	27%	11%	5%
Human activities are the main cause of the current climate change	3.8 (1.1)	4%	7%	27%	27%	35%
Climate change has serious consequences for humans and nature	4.2 (1.0)	1%	4%	19%	23%	53%

Notes: [1]Mean (M) and standard deviation (SD) on a 5-point scale of 1 'strongly disagree' to 5 'strongly agree'.

Supplementary Table 5. *Summary of Correlational Relations*

Correlational relations			**r**	**p**
interest in climate politics (strong)	← →	climate scepticism (strong)	-.37	<.001
climate scepticism (strong)	← →	personal relevance of climate change (strong)	-.59	<.001
interest in climate politics (strong)	← →	personal relevance of climate change (strong)	.59	<.001
a1_television	← →	a2_print media	.35	<.001
a1_television	← →	a3_online newspapers	.23	<.001
a1_television	← →	a4_information seeking online	.16	<.001
a1_television	← →	a5_social networks sites	.09	.001
a1_television	← →	a6_Twitter	.07	.007
a1_television	← →	a7_weblogs	.08	.002
a2_print media	← →	a3_online newspapers	.32	<.001
a2_print media	← →	a4_ information seeking online	.28	<.001
a2_print media	← →	a5_social networks sites	.22	<.001
a2_print media	← →	a6_Twitter	.28	<.001
a2_print media	← →	a7_weblogs	.25	<.001
a3_online newspapers	← →	a4_ information seeking on COP21 online	.41	<.001
a3_online newspapers	← →	a5_social networks sites	.32	<.001
a3_online newspapers	← →	a6_Twitter	.31	<.001
a3_online newspapers	← →	a7_weblogs	.36	<.001
a4_information seeking online	← →	a5_social networks sites	.45	<.001
a4_information seeking online	← →	a6_Twitter	.43	<.001
a4_information seeking online	← →	a7_weblogs	.51	<.001
a5_social networks sites	← →	a6_Twitter	.50	<.001
a5_social networks sites	← →	a7_weblogs	.49	<.001
a6_Twitter	← →	a7_weblogs	.62	<.001